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FORM PTO-1390 (Rev. 9-2001) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: 032553-021

U S APPLICATION NO (If known, see 37 C.F R 1 5): 10/049862

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH00/00434	16 August 2000	20 August 1999

TITLE OF INVENTION
HEAT EXCHANGER

APPLICANT(S) FOR DO/EO/US
Max ROTH

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☒ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   - b. ☐ has been communicated by the International Bureau.
   - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. ☒ is attached hereto.
   - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
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8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

copy of International Application No. WO 01/12507A1

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INTERNATIONAL APPLICATION NO. PCT/CH00/00434	INTERNATIONAL FILING DATE 16 August 2000	PRIORITY DATE CLAIMED 20 August 1999
TITLE OF INVENTION HEAT EXCHANGER		
APPLICANT(S) FOR DO/EO/US Max ROTH		

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INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/CH00/00434	16 August 2000	20 August 1999

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Patent
Attorney's Docket No. 032553-021

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	
Max ROTH	Group Art Unit: Unassigned
Application No.: Unassigned	Examiner: Unassigned
Filed: February 19, 2002	
For: HEAT EXCHANGER	

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination on the merits, please amend the above-identified application as follows:

IN THE ABSTRACT:

Please insert the attached Abstract to the specification.

IN THE CLAIMS:

Please amend the claims as follows:

1. (Amended) A method for producing a heat exchanger having a flow-through chamber for a heat transfer medium, in which two walls are disposed facing one another and are joined to make a hollow body through which a medium can flow, and the walls are fastened to one another at a plurality of connecting points inside a surface between edges of

the hollow body, the two walls being made to mesh with one another inside the surface between the edges of the hollow body by material deformation.

2. (Amended) The method of claim 1, wherein the material deformation is performed in punctate fashion, with a diameter of from 3 to 6 mm.

3. (Amended) The method of claim 1, wherein at least one wall is provided with circular indentations, and connections are made in a region of the indentations with spacing on all sides from an edge thereof.

4. (Amended) The method of claim 1, wherein the two walls are preshaped prior to being joined.

5. (Amended) The method of claim 1, wherein the hollow body is exposed to an internal pressure that is elevated compared to an external pressure.

6. (Amended) The method of claim 1, wherein denticulation of the two walls is stabilized by pressing on a ring around the material deformation and inserting a disk in the material deformation.

7. (Amended) A heat exchanger with two joined together walls and between them a flow-through chamber for a heat transfer medium, in which the walls are joined together at

a plurality of connecting points inside a surface between edges of the heat exchanger wherein the walls are made to mesh with one another at the connecting points inside the surface between the edges of the heat exchanger and are fastened to one another by means of denticulations.

8. (Amended) The heat exchanger of claim 7, wherein denticulations of the walls are embodied annularly.

9. (Amended) The heat exchanger of claim 8, comprising a ring encompassing a toothed place.

10. (Amended) The heat exchanger of claim 7, wherein the denticulations are produced by an upsetting-pressing process and without penetration of sheet metal used to form the walls.

11. (Amended) The heat exchanger of claim 7, wherein at least one wall comprises sheet copper with a thickness of from 0.3 to 0.8 mm.

12. (Amended) The heat exchanger of claim 7, wherein the denticulations are disposed with a mutual spacing of from 10 to 50 mm.

13. (Amended) The heat exchanger of claim 7, wherein the denticulations are disposed in at least one of rows and in a grid pattern.

14. (Amended) The heat exchanger of claim 7, wherein the denticulations are disposed inside an approximately circular indentation of the walls.

15. (Amended) A compression-molding sheet-metal joining method for mutual punctate fastening of two parallel walls that enclose a flow-through chamber of a heat exchanger.

16. (Amended) A construction kit for a heat exchanger system, comprising:

a plurality of heat exchangers; and

connecting elements for the connections of the heat exchangers, each heat exchanger having a flow-through chamber for a heat transfer medium, in which two walls are disposed facing one another and are joined to make a hollow body through which a medium can flow, and the walls are fastened to one another at a plurality of connecting points inside a surface between edges of the hollow body, the two walls being made to mesh with one another inside the surface between the edges of the hollow body by material deformation.

17. (Amended) The construction kit of claim 16, wherein the connecting elements are plug connectors.

Attachment to Preliminary Amendment

Marked-up Claims

4. (Amended) The method of [one of claims 1-3, characterized in that] claim 1, wherein the two walls are preshaped prior to being joined.

5. (Amended) The method of [one of claims 1-5, characterized in that claim 1, wherein the hollow body [(23, 33, 59)] is exposed to an internal pressure that is elevated compared to [the] an external pressure.

6. (Amended) The method of [one of claims 1-5, characterized in that the] claim 1, wherein denticulation of the two walls is stabilized by pressing on a ring around the material deformation and inserting a disk in the material deformation.

7. (Amended) A heat exchanger [(23, 33, 59)] with two joined[-]together walls [(13, 15)] and between them a flow-through chamber [(29)] for a heat transfer medium, in which the walls [(13, 15)] are joined together at a plurality of connecting points [(11)] inside [the] a surface between [the] edges of the heat exchanger [(23, 33, 59), characterized in that] wherein the walls [(13, 15)] are made to mesh with one another at the connecting points [(11)] inside the surface between the edges of the heat exchanger and are fastened to one another by means of [these] denticulations [(11)].

Attachment to Preliminary Amendment

Marked-up Claims

8. (Amended) The heat exchanger of claim 7, [characterized in that the mutual] wherein denticulations [(11)] of the walls [(13, 15)] are embodied annularly.

9. (Amended) The heat exchanger of claim 8, [characterized in that] comprising a ring [(82)] encompassing [the] a toothed place [(11) is provided].

10. (Amended) The heat exchanger of [one of claims 7-9, characterized in that] claim 7, wherein the denticulations [(11)] are produced by an upsetting-pressing process and without penetration of [the] sheet metal used to form the walls.

11. (Amended) The heat exchanger of [one of claims 7-10, characterized in that] claim 7, wherein at least one wall comprises sheet copper[, in particular] with a thickness of from 0.3 to 0.8 mm[, preferably 0.5 to 0.65 mm].

12. (Amended) The heat exchanger of [one of claims 7-11, characterized in that] claim 7, wherein the denticulations [(11)] are disposed with a mutual spacing of from 10 to 50 mm[, and preferably of between 20 and 30 mm].

Attachment to Preliminary Amendment

Marked-up Claims

13. (Amended) The heat exchanger of [one of claims 7-12, characterized in that] claim 7, wherein the denticulations [(11)] are disposed in at least one of rows [or] and in a grid pattern.

14. (Amended) The heat exchanger of [one of claims 7-13, characterized in that] claim 7, wherein the denticulations [(11)] are disposed inside an approximately circular indentation [(59)] of the [wall] walls.

15. (Amended) [The use of a] A compression-molding sheet-metal joining method for mutual punctate fastening [(11)] of two parallel walls [(13, 15)] that enclose a flow-through chamber [(29)] of a heat exchanger.

16. (Amended) A construction kit for a heat exchanger system, [having] comprising:

a plurality of heat exchangers [as defined by one of claims 6-12]; and [having] connecting elements for the connections of the heat exchangers, each heat exchanger having a flow-through chamber for a heat transfer medium, in which two walls are disposed facing one another and are joined to make a hollow body through which a medium can flow, and the walls are fastened to one another at a plurality of connecting points inside a surface between edges of the hollow body, the two walls being made to

Attachment to Preliminary Amendment

Marked-up Claims

mesh with one another inside the surface between the edges of the hollow body by material deformation.

17. (Amended) The construction kit of claim 16, [characterized in that] wherein the connecting elements are plug connectors.

18. (Amended) The construction kit of claim 16 [or 17], having a pump.

19. (Amended) The construction kit of [one of claims 16-18] claim 16, having a hot-water tank.

20. (Amended) A method for producing a heat exchanger [(23, 33, 59)] having a flow-through chamber [(29)] for a heat transfer medium, in which two sheet metal walls [(13, 15)], are disposed facing one another and are joined together to make a hollow body [(23, 33, 59)] capable of experiencing a flow through it, and the walls are fastened to one another at a plurality of connecting points [(11)] inside [the] a surface between the edges of the hollow body [(23, 33, 59), characterized in that] wherein in at least one [and preferably both] of the walls [(13, 15)] at the connecting points [(11)] inside the surface between [the] edges of the hollow body [(23, 33, 59)], circular indentations [(59)] that provide reinforcement by deformation of [the] material are shaped out, and the [sheet-metal] two

[0003] Since the heat transfer paths and the heat transfers between the sheet-metal faces and the pipe carrying the medium impair the capacity of a heat exchanger, many attempts have been made to put heat exchanger faces with the greatest possible surface area into direct contact with the media on both sides. This is especially true for all flat heat exchangers. Flat heat exchangers have a flow-through chamber for a heat transfer medium which is relatively flat in form. The problem in flat heat exchangers, which have a wall with the largest possible surface area in contact with the media on the inside and the outside but the smallest possible internal volume, is the pressure difference between the internal pressure and the external pressure. This difference has to be absorbed by a more or less flat-surfaced wall. The two walls extending approximately parallel are pressed apart by an elevated internal pressure. They must therefore be joined together at many points inside the surface between the edges of the flat heat exchanger. The tensile stress on the connecting points is considerable. For connecting metal sheets in a way that absorbs this tensile stress, until now practically only welding could be considered.

[0004] Flat heat exchangers made of steel are available on the market that are made from two preshaped walls spot-welded to one another. This production process requires steel or special steel (ferrous metals) as material. However, ferrous metals are not optimal heat conductors. If flat heat exchangers are to be produced from

copper, which in terms of heat conduction is the ideal material, recourse must be had to riveting and soldering. Riveting, however, has the advantage that both metal sheets are perforated at the riveting points, and tightness at these points is attainable, if at all, only at great effort and expense. Leaks are quite likely later on as well, for instance from thermal expansion and contraction of the metal sheets. It is almost impossible to make soft-soldered points inside the surface of the heat exchanger, and they withstand only very slight tensile stresses. Hard soldering, conversely, anneals the material and makes it even softer.

[0005] A compression-molded connection (such as TOX connection) is known with which metal sheets of all kinds can be joined together. Primarily, this compression-molded connection replaces spot welding in the automotive industry, but it also replaces riveting in aircraft construction. By an upsetting-pressing operation, metal sheets are joined absolutely tightly and without surface damage or penetration. With a simple round male die, the sheets to be joined are first pressed together into a female die. Upon a further buildup of force, the material toward the male die is forced, inside the material toward the female die, to flow outward behind the material toward the female die. This is made possible in that the positively displaced material in the female die is given a free space in the female die into which it can escape. Disadvantageously, such a connection point can even be pressed flat again. Similar

positive-engagement compression-molded connections are also achieved using a modified technique.

[0006] Such compression-molded connections are used to join metal sheets, resting flatly on one another, together in such a way that enough shear tensile force can be absorbed by the connection. Accordingly, the sheets cannot be detached from one another by tension in the plane of the sheets. Extraction forces of the compression-molded connections perpendicular to the plane of the sheets are hardly known. In copper sheets, extraction forces are entirely unknown. Professionals in the field consider the joining of copper sheets by means of standard compression-molded connections to be unstable. The standard compression-molded connection is circular and is offered in diameter sizes of 3, 4, 5, 6, 8, 10 and 12 mm. It is recommended with the largest possible diameter that space conditions allow be selected in each case.

Object of the Invention

[0007] It is now the object of the invention to propose a method for producing heat exchangers, by which method a connection of the two walls is attained that can withstand an overpressure of the internal pressure, prevailing in a chamber between the walls, of up to 4, 6 or 10 times 10^5 Pa, for instance. Furthermore, the method should offer the capability especially of also using copper and other nonferrous

metals for the walls to be joined. The production of heat exchangers should be as economical as possible, and in terms of shape and choice of material the heat exchangers should be capable of being designed for the most various fields of use.

Description of the Invention

[0008] According to the invention, this is attained in that to fasten the walls to one another inside the surface between the edges of the heat exchanger, the walls are made to mesh with one another by deformation of the material. The meshing by positive engagement is accomplished merely by means of an upsetting-pressing operation, without injuring the wall or making a damaging change to the structure of the material. Subsequently both walls remain free of apertures or cracks, so that even loosening of the connecting point need not cause any leakage. Such denticulations can be made linearly on the order of profile sections, given a sufficient material thickness of the wall.

[0009] The material deformation is preferably done in punctate form. The term "punctate material deformation" is understood to mean that the material is deformed at an approximately circular place having a diameter of between 2 and 15 mm, and preferably between 3 and 8 mm, depending on the material thickness of the walls to be joined and on the stress to be expected. At a wall thickness of approximately 0.5 mm and with a pressure difference between the internal pressure and the external

provided symmetrically with indentations are placed on one another with the reinforced points.

[0015] Advantageously, the heat exchanger is soldered annularly all the way around before the compression-molded connection is made. As a result, the change in length of the sheet (with copper, the expansion is in the range of 1.3 to 1.5 mm per 100EC of temperature difference and running meter) as a consequence of material heating up to 270EC in soldering can be prevented from causing separations of peripheral compression-molded connections.

[0016] Two opposed side edges of the flat heat exchanger are expediently lock-seamed for longitudinal reinforcement, and at least one of them is closed by soldering. The other two opposed end edges serve as connection sides for the heat transfer medium. These edges are advantageously equipped with an end pipe of the same metal that comprises the wall. To that end, the wall sheets are drawn or compressed into shape in channel-like fashion and wrapped around an end pipe provided with slots or bores. The slots or bores are aligned with the flow-through chamber, so that the interior of the end pipe communicates with the flow-through chamber of the heat exchanger. After that, the end pipe and the sheet-metal wall are soldered to one another. An immersion soldering process is suitable for this purpose. The end pipe is expediently gripped by the sheet-metal walls over at least half of its

circumference, and as a result the pipe is clamped between the two face ends, preshaped in quarter-round shape, of the walls.

[0017] So that the corners of the hollow body will connect tightly to the end pipe and be securely sealed by the immersion soldering, an opening, to be disposed on the corner of the hollow body, of the end pipe is advantageously provided with a collar that extends into the flow-through chamber. The collar can be drawn out from the pipe wall material. Alternatively, a part of the end pipe that protrudes laterally past the hollow body can also be shaped around the edge of the hollow body from outside. This makes it possible to place the openings at a spacing from the edge of the hollow body, which in turn makes it possible to insert plug connections into the end pipe that do not extend past the width of the hollow body.

[0018] The end pipe ends covered with solder after the immersion soldering are then rubbed clean, and their internal diameter is brought exactly to a certain dimension. This dimension is adapted to the external size of a connecting piece that is introduced, with one or more, preferably two, sealing O-rings, into the end pipe end. An arrangement in which the connecting piece surrounds the end pipe end is also conceivable. It is also possible for the end pipe to be provided with T-pieces somewhere along its length. These pieces can also be coupled to pipes or other components of a system using plug connections.

[0019] Connecting system components by means of plug connections makes construction easier and enables fast assembly, as well as the use of such standard parts as angle pieces and other fittings, and uncomplicated adaptation of an existing system. A construction kit, for instance with five flat heat exchanger elements and a collector area of one square meter, is advantageously equipped with plug connectors. This makes do-it-yourself assembly easier and allows even temporary installation of a collector system, for instance in a mobile home or camper. For transportation, for instance when traveling onward in an RV, this system can be removed quickly and its individual parts can be stowed. Such construction kits can advantageously be supplemented with a collector system frame, a pump, a hot-water tank, and in any case an expansion vessel.

[0020] In a heat exchanger with two joined-together walls and between them a flow-through chamber for a heat transfer medium, according to the invention the walls inside the surface between the edges of the heat exchanger are made to mesh with one another at many points with deformations of the walls and are thereby fastened to one another.

[0021] The deformations of the walls are advantageously punctate. Such compression-molded connections are expediently arranged in rows. They are advantageously disposed in a mutual spacing of 10 to 50 mm, preferably between 20

other catalytic metals, or cooling surfaces or surfaces that output waste heat for air conditioners, to name only a few applications.

[0028] In a method for producing a heat exchanger having a flow-through chamber for a heat transfer medium, in which two walls, are disposed facing one another and are joined together to make a hollow body capable of experiencing a flow through it, and the walls are fastened to one another at a plurality of connecting points inside the surface between the edges of the hollow body, it has proved highly advantageous, regardless of the type of connection, that in at least one and preferably both walls at the connecting points inside the surface between the edges of the hollow body, circular indentations that provide reinforcement by deformation of the material are shaped out. The sheet-metal walls are subsequently joined together inside these indentations by means of a material-locking or form-locking connection. A heat exchanger made by this method has dimensionally stable walls. Advantageously, the indentations are disposed in a grid, and the grid spacing of connecting points is adapted to the sheet-metal thickness and the properties of the material.

Brief Description of the Drawings

[0029] The invention is described in further detail below in terms of examples shown in the drawings. Shown are

[0030] Fig. 1: a schematic section through a fastening point, attained by means of compression molding, between two metal sheets in accordance with the prior art;

[0031] Fig. 2: a schematic drawing of a flat heat exchanger according to the invention;

[0032] Fig. 3: a schematic section through the fastening points of a flat heat exchanger;

[0033] Fig. 4: a heat exchanger comprising one pipe;

[0034] Fig. 5: a schematic illustration of the production of a flat heat exchanger according to the invention, with preshaped metal sheets;

[0035] Fig. 6: a schematic illustration of a metal sheet with indentations shaped at the places intended for the fastening points, the indentations being disposed symmetrically to a folding line of the sheet;

[0036] Fig. 7: the sheet of Fig. 6, folded together and partly tacked together by compression-molded connections;

[0037] Fig. 8: a flat heat exchanger with end pipes;

[0038] Fig. 9: a cross section through a compression molding point in the heat exchanger of Fig. 8;

[0039] Fig. 10: a plug connector for connecting the flat heat exchanger of Fig. 8;

[0040] Fig. 11: a simple water heating system;

[0041] Fig. 12: a water heating system with a pump, hot-water tank, and expansion vessel.

Description of the Exemplary Embodiments

[0042] The compression-molded connection 11, which is shown in a schematic section in Fig. 1, is in accordance with the prior art and was developed as an alternative to spot welding, especially for the automotive industry. With compression-molded connections 11 of this kind, metal sheets 13, 15 resting flat on one another can be joined inside only a few seconds at many places. The connection 11 transmits tension and shear forces. It is produced by pressing compression molds against the metal sheets 13, 15 on both sides. The sheet 13 is everted downward into a counterpart mold by means of the compression mold acting from above in Fig. 1. The lower sheet 15 is made to bulge outward at the bottom simultaneously with the upper sheet 13. The counterpart mold of the downward-acting compression mold has an annular indentation and a central raised portion on the bottom of the mold. The material compressed into the counterpart mold is therefore pressed into this annular indentation and forms an annular thickened portion 17. Several variants of methods for making connections by compression molding with which a comparable result is attained are known.

[0043] Although the two compression molds for pressure orientation of the male die have approximately parallel mold walls, a denticulation is created between the two sheets. The lower sheet 15 surrounds the downward-pressed piece of sheet metal 19 of the upper sheet 13 with an indentation edge 18 at a narrower radius than the outer radius of the downward-pressed piece 19. The pressure of the compression process causes the downward-pressed sheet-metal piece 19 to deviate, because it expands crosswise to the pressure direction and thus forms a crown 21 under the lower sheet 15. This crown 21 has a larger radius than the shortest radius of the lower sheet 15 in the deformed region. As a result, the sheets 13, 15 with the crown 21 and indentation edge 18 dig into one another in such a way that as a rule they can be taken apart without harming the sheet.

[0044] This deformation can be embodied linearly. To prevent the forces occurring in the crown 21 and the indentation edge 18 as a result of the use of the flat heat exchanger from causing the two sheets 13, 15 from coming loose from one another, the compression-molded connection 11 is advantageously embodied as punctate or annular.

[0045] Fig. 2 shows a solar collector panel 23. Two sheet copper walls 13, 15, only one of which is visible in the drawing, are joined by many punctate compression-molded connections 11. These connections are disposed in a square

grid. The edges 25 are traditionally joined and sealed with soldered lock-seams. Pipes 27 are soldered in place on diagonally opposed corners. The sheets 13, 15 were joined together, resting flatly on one another, and even after the collector has been manufactured still rest flatly on one another. The flow-through chamber for a heat transfer medium is not widened, by being put under pressure, until after the collector 23 is finished. The hollow body, made of sheet metal 0.2 mm thick, is inflated with a pressure of four atmospheres, for instance ($4 * 10^5$ Pa). The sheet metal walls 13, 15 are deformed in the process, and the external dimensions of the hollow body 23 become somewhat smaller, and the flow-through chamber is opened.

[0046] Fig. 3 schematically shows a section through an inflated hollow body 23. At the fastening points 11, the sheet metal walls 13, 15 remain joined and in the closest possible contact. In between, the inflation pressure or test pressure for testing the tightness of the collector element 23 is capable of forcing the walls 13, 15 apart. This creates a flow-through chamber 29 between the walls 13, 15. The flow-through chamber 29 is very small in proportion to the collector area and is present over practically the entire surface. The collector area is cooled directly on the back side at nearly every point. The only exceptions are the compression-molded connection points 11. However, these have a very small diameter, of about 6 mm, so that the heat transfer paths remain very short.

individual presses. This deformed face is advantageously pressed in and with a torque exerted on the face reinforces the material connection face 79. The reinforced material of two sheets, placed back to back on one another with the deformed connecting faces 79, can now be joined, either by means of a compression molding point as shown or by some other type of connection located centrally inside this indented connection face 79. The indentations 59 assure a defined flow-through chamber 29 and, in conjunction with a gridlike arrangement of the deformations and a maximum spacing of the connection points 11, they also assure a dimensionally stable surface of the heat exchanger.

[0056] The compression-molded connection 11 in Fig. 9 is additionally equipped with parts 80, 82 that secure the connection. These parts 80, 82 are of brass, since it is harder than copper and has a lower coefficient of temperature-dependent expansion. A disk 80 is press-fitted into the stamped-in indentation in the compression-molded connection 11, and a ring 82 surrounds the eversion, pressed into the female die, of the compression-molded connection 11. The disk and the ring together secure the interlocking between the indentation edge 18 and the crown 21. This stabilization of the compression-molded connection allows higher loading in terms of temperature fluctuation and assures a stronger connection force. It can

expediently be employed in high-pressure heat exchangers or in heat exchangers with temperature differences.

[0057] The connection between the heat exchanger and the forward and reverse flow lines or the adjacent heat exchanger is advantageously accomplished via plug connectors. One such plug connector is shown in Fig. 10. The plug connector 81 comprises a pipe. This pipe is provided with two encompassing grooves, one on each of its two ends, in each of which grooves an O-ring 83 is located. The dimensions of the outside diameter and of the O-ring of the plug connector are adapted to the inside diameter of the pipe, that is, the end pipe, to be joined. To allow the plug connector 81 to be inserted uniformly into the two pipe ends to be joined, a stop 85 is provided in the middle. This stop is formed by an enlargement of the diameter.

[0058] Fig. 11 shows a simple water heating system with four joined-together solar collector elements 91 and a hot-water reservoir 93. The tap water is heated directly in the collectors 91. The reservoir 93 is connected in a circulatory system to the collectors 91. An even simpler variant makes do without a hot-water reservoir 93. Fig. 12 shows a more-complicated water heating system, in which the collector circuit 95 is separate from the tap water circuit 97. The collector circuit 95 is driven by a pump 99. It has an expansion vessel 101. A heat exchanger register 103 is

disposed in the hot-water tank, and with this register the water, heated in the collectors 91, passes its heat on to the tap water. It can also be seen from Figs. 11 and 12 that the most various arrangements of collector elements 91 are possible.

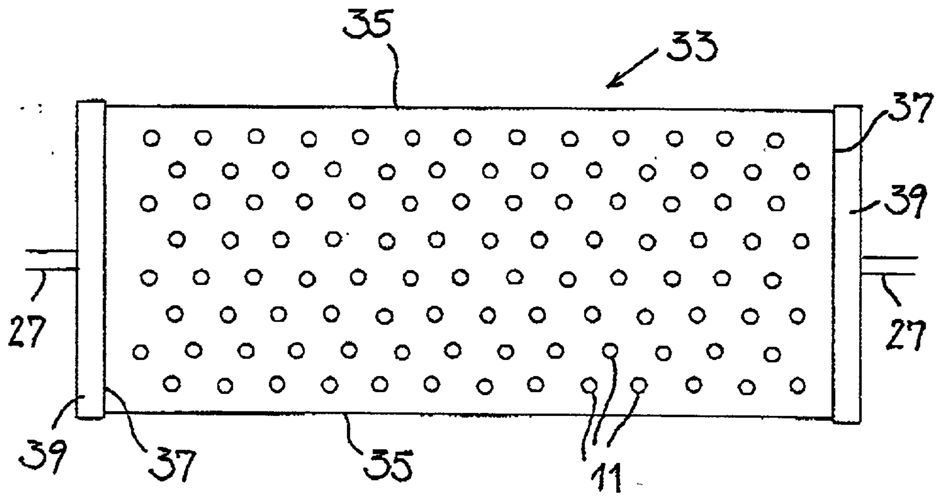

Fig. 4

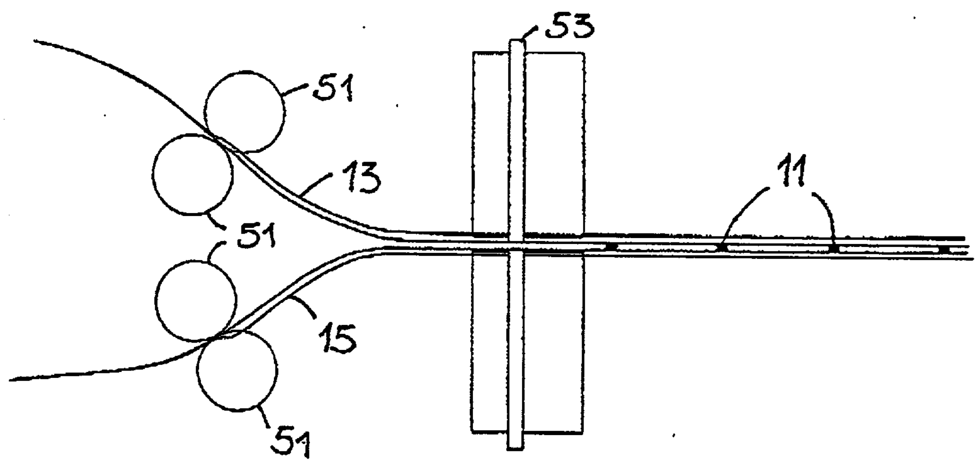

Fig. 5

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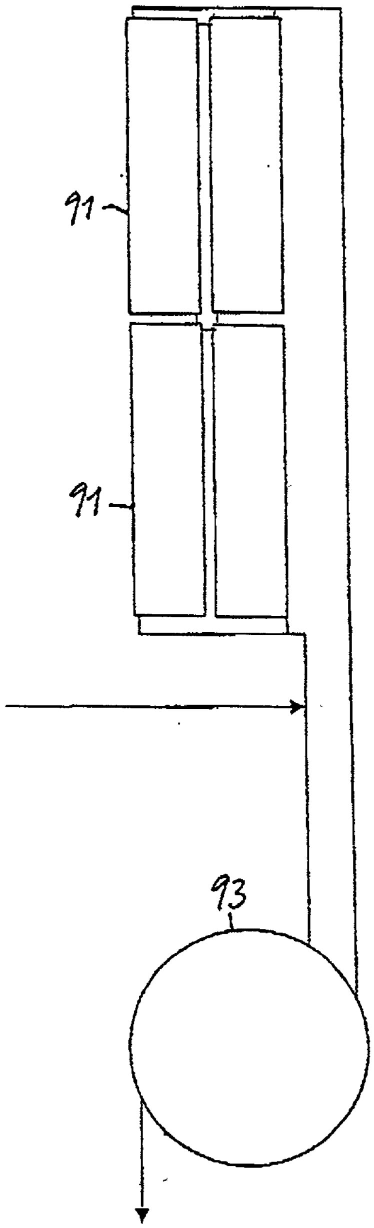

Fig. 11

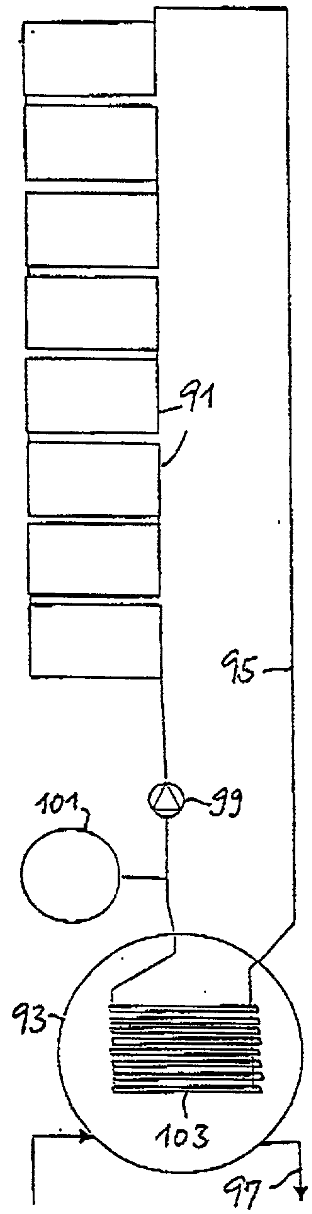

Fig. 12

032553-021
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COMBINED DECLARATION AND POWER OF ATTORNEY FOR UTILITY OR DESIGN PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

HEAT EXCHANGER

the specification of which (check only one item below):

- [ ] is attached hereto.
- [ ] was filed as United States application
  Number ______ on ______
  and was amended on ______ (if applicable)
- [x] was filed as PCT international application
  Number PCT/CH00/00434 on 16 August 2000
  and was amended on ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, §§119 (a)-(d), 172 or 365 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. §§119(a)-(d), 172 or 365:				
COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 U.S.C. §§119, 172 or 365	
Switzerland	CH1999 1526/99	20 August 1999	x Yes	No
PCT	PCT/CH00/00434	16 August 2000	x Yes	No
			Yes	No
			Yes	No
			Yes	No